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MEMORANDUM

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AZ CORP COMMISSION
DOCKET CONTROL

Arizona Corporation Commission
DOCKETED
APR 13 2016
DOCKETED BY

TO: Tom Broderick
Director
Utilities Division

THRU: Del Smith
Engineering Supervisor
Utilities Division

FROM: Chukwunonso Chidebell-Emordi
Electric Utilities Engineer
Utilities Division

DATE: April 13, 2016

SUBJECT: Interconnection Rulemaking Technical Workshop, Docket No. RE-00000A-07-0609

The presentations from the April 13, 2016 Interconnection Rulemaking Technical Workshop have been docketed.

DG Interconnection Approval Process

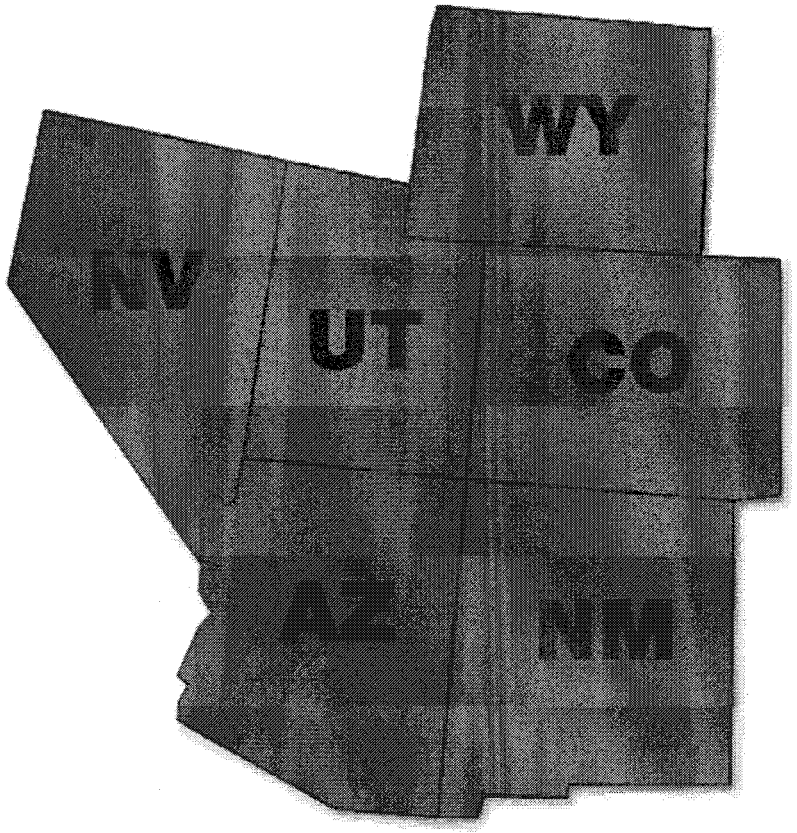
Neil Kolwey, Sr. Associate, SWEEP

April 13, 2016

SWEEP

SOUTHWEST ENERGY EFFICIENCY PROJECT

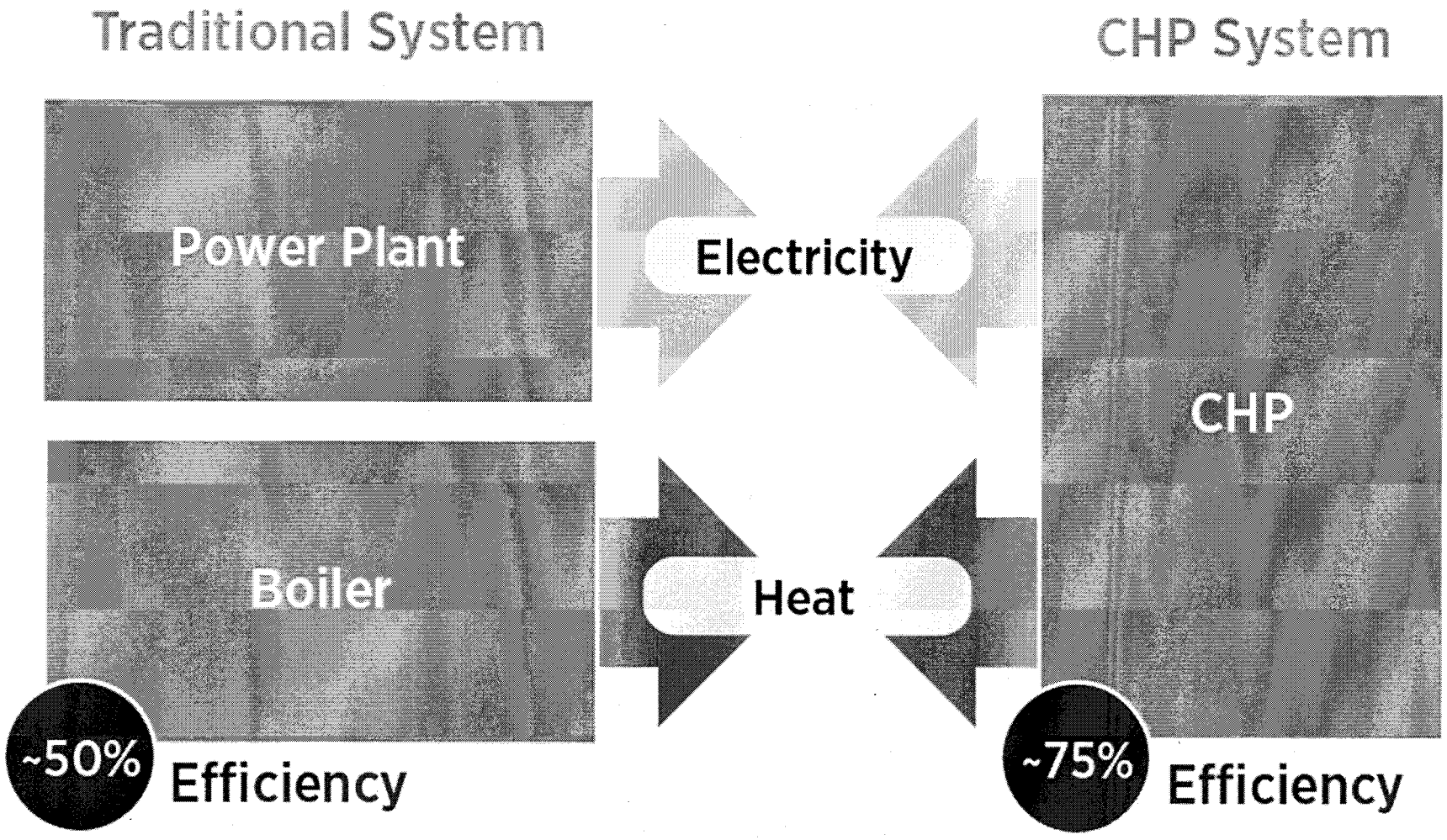
Saving money and protecting the environment by advancing energy efficiency in the utility, buildings, industrial, and transportation sectors



Overview

- Benefits of CHP
- Need for interconnection standards
- Screening requirements and supplemental review;
- Pre-application reports;
- Updates to the standards

CHP Saves Energy



CHP Benefits

For customers:

- Energy cost savings
- Improved reliability
- Reduced carbon footprint

For utilities:

- Reduce grid constraints during system peaks
- Achieve energy efficiency resource standard goals
- Achieve Clean Power Plan goals

Importance of Interconnection Standards

- 35 out of 50 states have interconnection standards
- AZ has a strong market for solar and CHP and needs a state-wide standard
- The draft rules are a good start but need to be updated based on best practices from other states

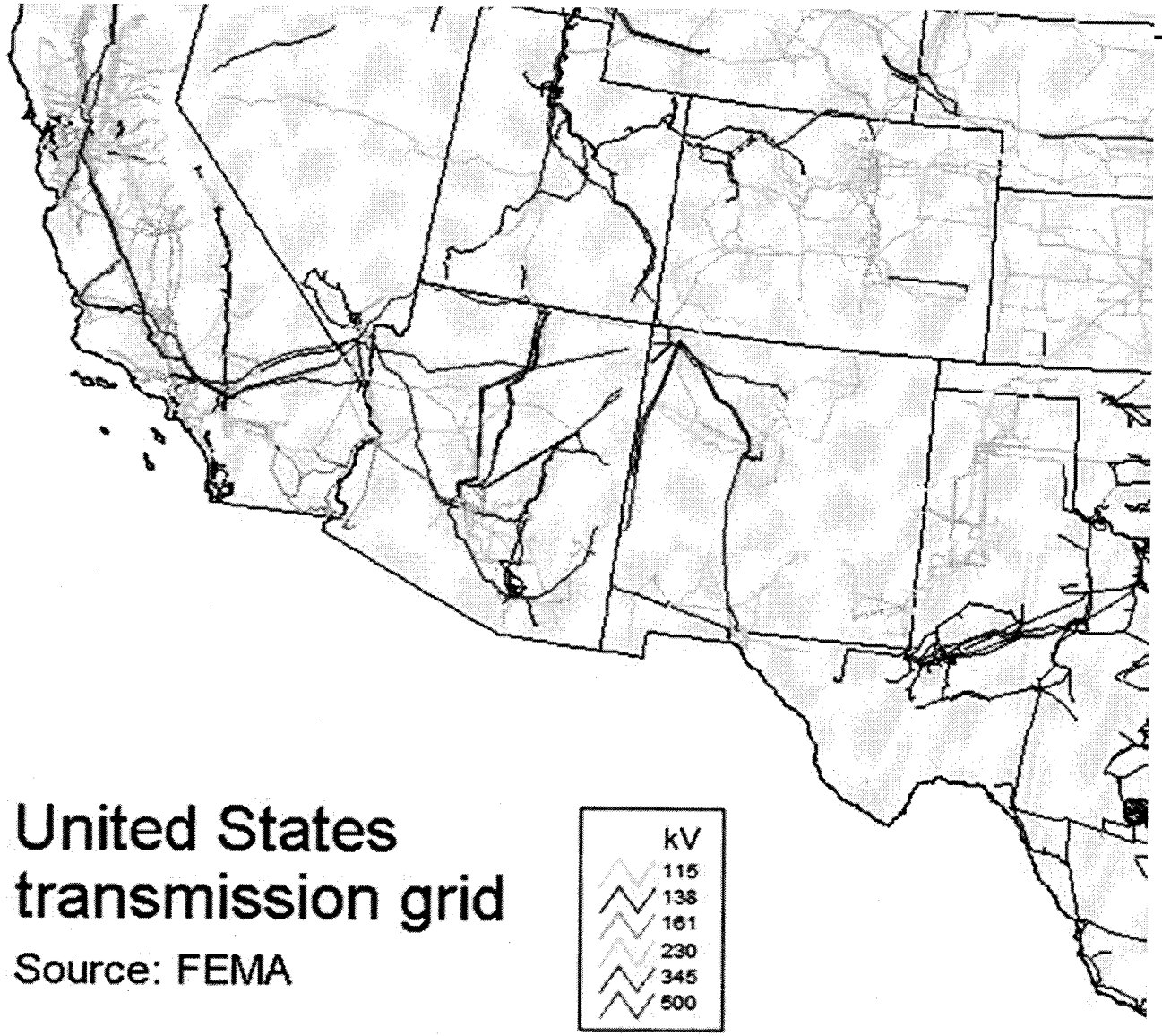
Screening Requirements

- Fast Track Eligibility and Screening tests should follow IREC 2013 Model Interconnection Procedures
- Supplemental Review process should be clarified

Pre-Application Reports

- **What it is:** Description of system conditions at proposed point of interconnection
- **Why it's helpful:**
  - For the applicant: learn about system conditions at proposed point of interconnection before submitting a full application
  - For the utility: reduce volume of full applications

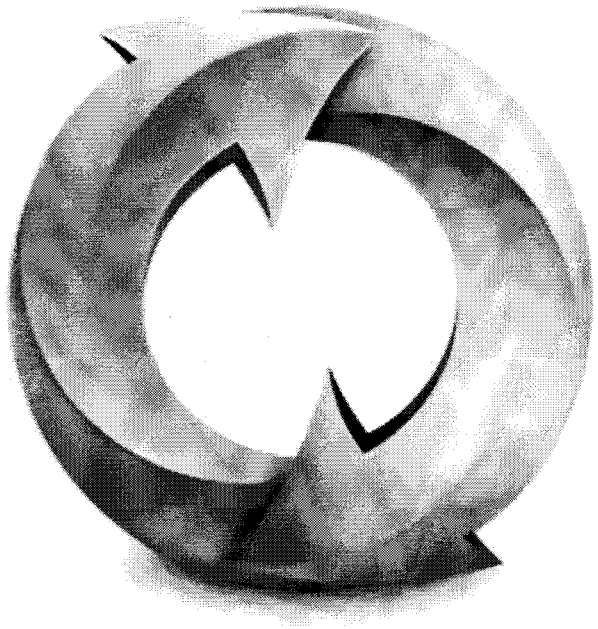
Pre-application - Maps



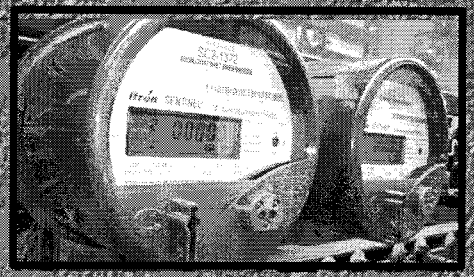
United States transmission grid

Source: FEMA

Updates to the Standards



- Standards may require periodic updates - with Commission approval
- Technical Working Group – meet quarterly or as needed to discuss technical issues, proposed updates




Rulemaking Regarding Interconnection of Distributed Generation Facilities

(Docket No. RE-0000A-07-0609)

Don McAdams

Principal Standards Engineer

TEP

Tucson Electric Power

April 13, 2016

UniSource Energy SERVICES

Agenda

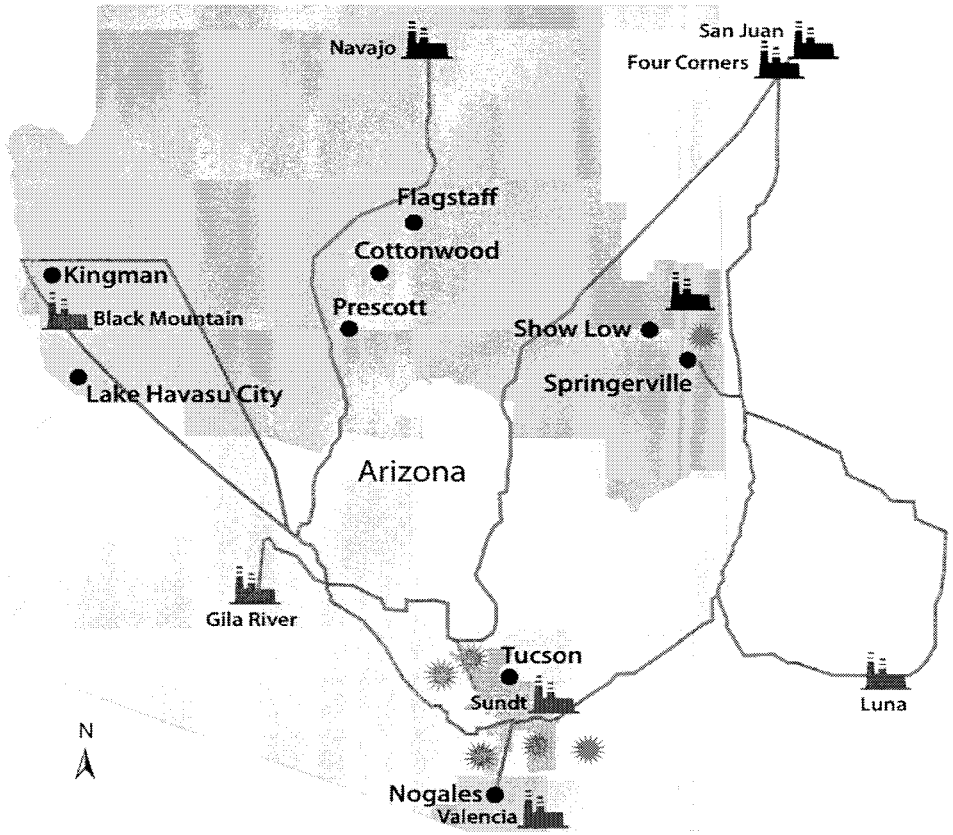
- Overview
- Process Standardization
- AC Disconnect Switch
- Process Screens
- New Technology
- Recap

Service Areas

SERVICE AREAS / CUSTOMERS

- Tucson Electric Power Service Area
- UNS Gas Service Area
- UNS Electric Service Area
- UNS Gas & Electric Service Area

- Transmission Line
- Coal-Fired Power Plant
- Natural Gas-Fired Power Plant
- Community-Scale Solar Power
- Company Offices



TEP Tucson Electric Power

UniSource Energy SERVICES

Overview

	TEP	UNS Electric
Service Territory Population	1,000,000	250,000
Retail Peak Demand (2015)	2,218 MW	429 MW
Customers	417,000	93,000
Residential DG Customers	~ 11,000	~ 2,000

TEP Tucson Electric Power

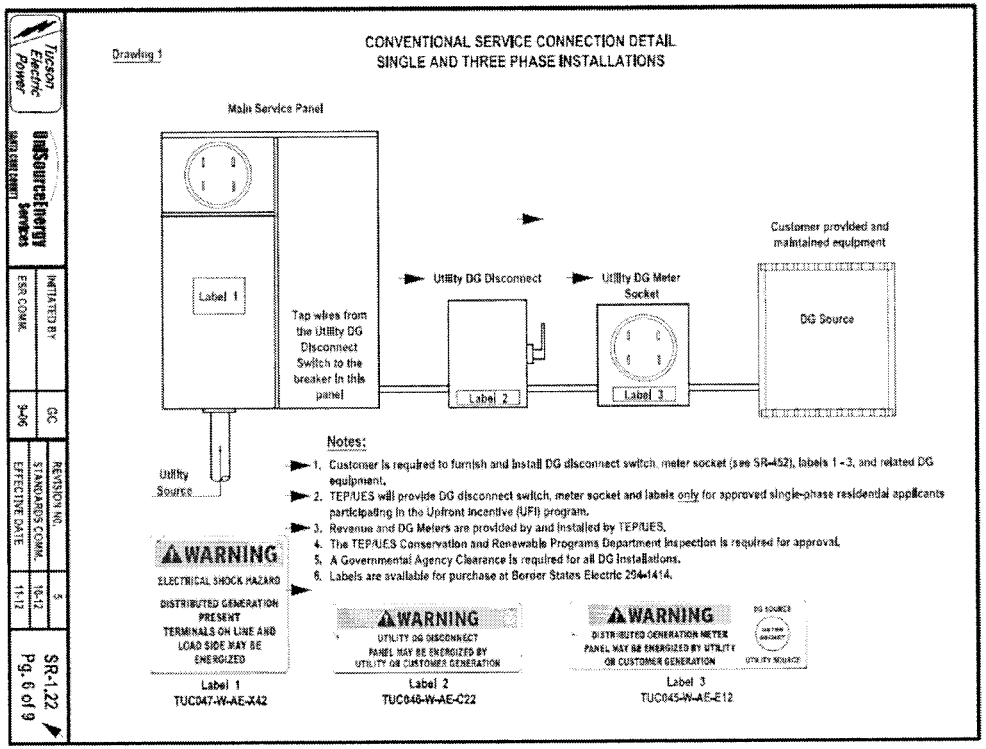
UniSource Energy SERVICES

Process Standardization

- Generally support standardized
  - Application forms, fees, & requirements
  - Study agreements
  - Pre-operational testing
  - Process and use of a modified IREC or FERC process
- Utility needs flexibility in determining technical requirements
  - Interconnection agreements
  - Technical manual
  - Technical specifications
  - Study thresholds

AC Disconnect Switch

- Strongly support requirement of an AC disconnect switch
  - Ensures the Safety of our Workforce
    - Customer panel breaker is not a suitable disconnecting means per NFPA 70E
    - Safety device for both utility workers & emergency responders
    - Not redundant
- Disconnect Switch Benefits
  - Personnel Safety
  - Visible-open, lockable in the open position
  - Consistency for all DG systems
  - Easier and faster maintenance
  - Less disruption to customer
  - TEP/UNSE supplies the disconnect for residential customers at no cost



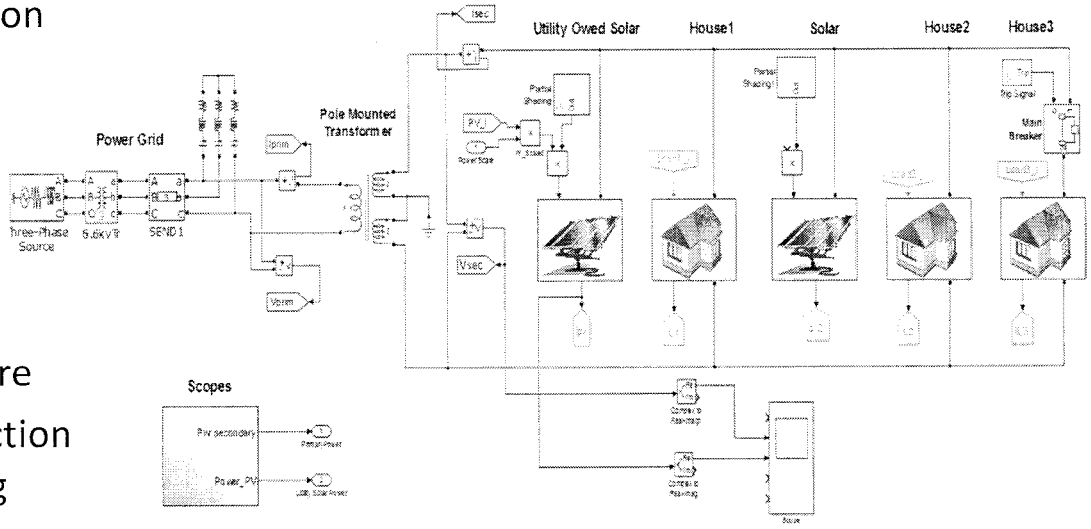
Screens

- Do not support a blanket increase of the system size thresholds presently defined by the Level screens
  - The screens do not always result in additional studies
  - The screens support the process for escalation if a project could pose a risk
  - The screens should not be interpreted as automatic project approval if they are met
- Support further exploration of the concept of supplemental reviews

New Technology

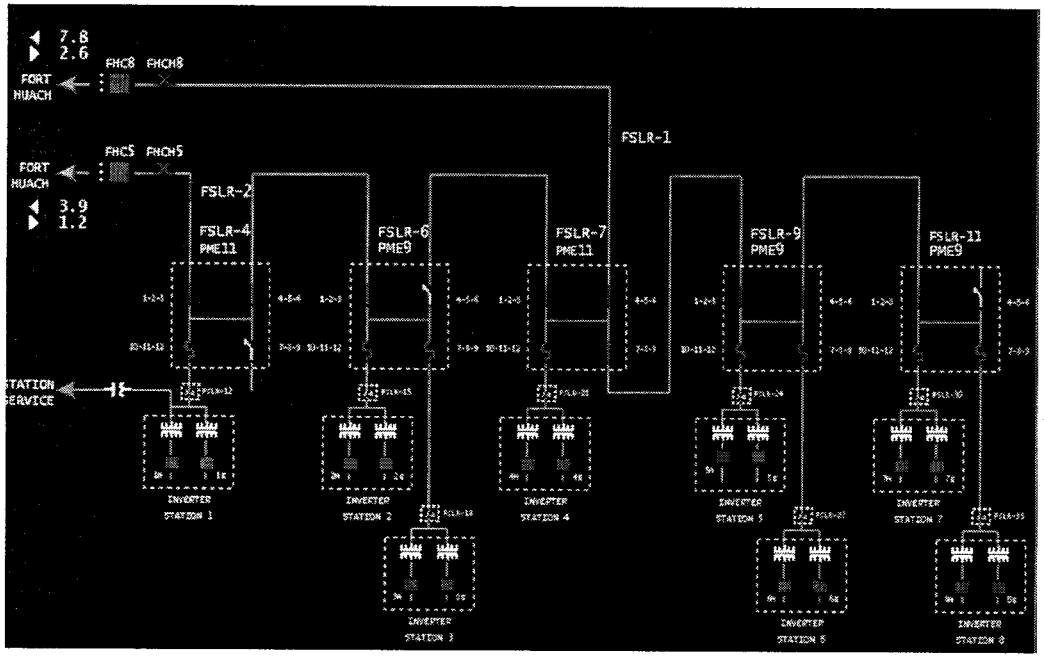
Micro-Grids

- TEP is researching the integration of micro-grids
  - Simulations
  - Volt/VAR Optimization
  - Advanced Inverters
  - Energy Storage
  - Grid Management Software
- Micro-grids must break connection from the grid before energizing local source
- Support private micro-grids with the appropriate grid service charge and operational protocols



New Technology

- Advanced Inverters
  - Support creating an advanced inverter requirement/specification
  - Standardized factory settings and testing procedures would be beneficial



New Technology

- Energy Storage
  - Support inclusion of energy storage in definition of "Generation Facility"
  - Support requirement of advanced inverters for energy storage
  - Additional study work is needed to better understand the impacts of energy storage on the grid
  - Energy Storage and Rotating Machine technology should follow study track

Recap

- Utility specific technical manuals
- AC Disconnect switch is critical to safety
- Adopt process standards for new technology to support continued integration of DG

ACC Interconnection Rules Workshop
Interconnection Process Topics

Marc Romito, Manager
APS Renewable Energy

April 13, 2016

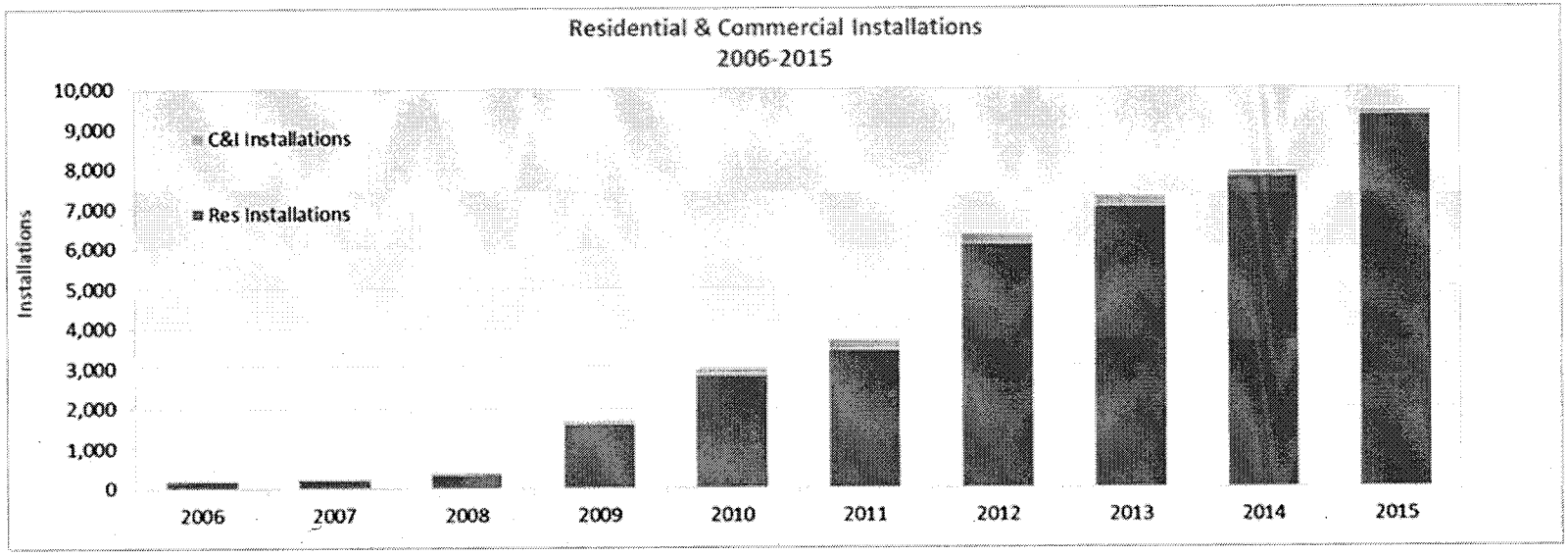
aps®

Agenda

- Introduction – Residential and Small Commercial PV
- Safety
- Reliability
- Process
- Questions

Context

- High volume of interconnections
  - 42,000+ existing
  - Grows by ~ 1,300 – 1,500/Mo
  - 100+ PV installers
- High-penetration – must plan ahead to maintain system reliability



Safety – Interconnecting is a serious issue

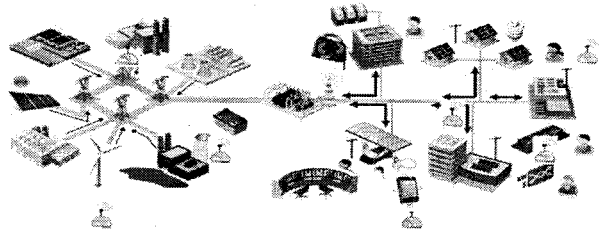
- Must be first and most important priority
  - Customers, Crews, Contractors
- Electrical equipment is very dangerous
  - Avoid injury or fatality
  - Most people do not understand the hazard
  - Invisible and instantaneous
- Crew safety not covered by code
  - Examples: Access and APS clearance requirements

Safety

- Rules must reflect zero tolerance for risk
  - Avoid electrical and non-electrical hazards
    - Customer, Crews, Contractors

- Adaptable for discretionary modifications
  - New hazards identified
  - Absolute and quick response
    - Code changes, jurisdiction changes, field experiences

Reliability



- APS provides service 24-7, 365
  - Product is produced and consumed instantly
- Interconnecting to an increasingly complex and dynamic grid
  - 10% APS feeders have reverse power flow
    - More than 300 hours annually
    - Growing issue
    - Complex diagnostics and planning
  - High penetration causes power quality issues
  - Each feeder is different

Reliability

- PV production does not typically match customer usage
- Rules must reflect ability to adapt to change in real-time
  - Technologies change
  - Codes and laws change
  - Feeders change
- Speed of change is increasing

Process – Adaptable and transparent

- Current process:
  - Automated
  - Training Supplied
  - Checklists and Templates provided
  - Adaptable
  - Tracked for record keeping and accountability
- Rules must maintain adaptability

Process

- Customer Submits Application
- Installer Submits Application
- Customer and Installer Application Review and Approval
- Installer installs the system
- Final Review
- Billing changes made/Inspection/Meter Set

Process

- Process should take ~20 days
- ACC does not regulate PV/DER installers
  - 66% of application error rate
  - 20% re-application error rate
  - All safety/reliability related
  - High turnover rate of installer administration
- Financial interest vs safety/reliability
- Must be adaptable to system conditions

Conclusion

- Safety is #1
- Rules must be dynamically adaptable
- Utility is the proponent of system change and installer accountability – in real-time
- Process must be adaptable and transparent

ACC Interconnection Rules Workshop
Interconnection Technical Topics

Scott Bordenkircher, Director
APS T&D Technology Innovation and Integration

April 13, 2016

aps®

Agenda

- Introduction
- Technical Topic Discussion
  - Utility Disconnect Switches
  - Network Service Considerations
  - Advanced Inverters
  - Microgrids
  - Energy Storage
- Questions

Introduction

- Safety and reliability are paramount
- These technologies are just the tip of the iceberg
- Current technologies and standards are constantly changing

Utility Disconnect Switches

- The Utility Disconnect Switch is adjacent to the customer's Service Entrance for the purpose of isolating the generating facility from the grid
- APS requires a visual open and lockable disconnect switch as part of our Switching and Tagging Procedure
- First responders use visual open disconnects when responding to fire/electrical hazards
- Utilizing circuit breakers in lieu of a visual open and lockable disconnect does not qualify or establish a safe work area

Network Service Considerations

- Network Service provides extra-high availability power to large customers such as hospitals and high rises
- Network Service is especially susceptible to current imbalance, reverse power flow, and voltage imbalance; all of which interconnected generation can produce
- Interconnected generation over 10kW is only considered after detailed engineering review and is subject to APS approval due to enhanced risk

Advanced Inverters

- Advanced inverters modernize the AC/DC interconnection
- Core of APS Solar Partner Program research
- Multiple functions like: voltage regulation, over-frequency protection, and scalable power output
- IEEE 1547a-2014 provides the technical requirements – UL specs not final
- Hawaii and Germany require advanced inverters for all interconnections to mitigate grid impacts

Microgrids

- A microgrid is an electrical system that can island and reconnect (in parallel) to the grid
- Customers have installed Behind-the-Meter (BTM) microgrids in the form of backup generation for decades following APS's standard non-FERC (Federal Energy Regulatory Commission) interconnection procedures
- APS interconnection procedures take into account multiple methods for connection (i.e. open-transition & parallel) with varying requirements

Energy Storage

- APS has standard 1-line diagrams for BTM interconnection of energy storage
- APS recently revised the BTM solar with battery backup template to accommodate changes in metering technology
- Act as both a load and a source
- Grid-tied energy storage would follow the FERC or non-FERC interconnection process depending on the application and circumstances
- Stationary battery storage will need to comply with UL 9540 when released (sometime in 2016)

Questions?

aps®


HYDE ENGINEERING
Tripp Hyde, PE
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Arizona ACC Interconnection Workshop - 4/13/16
Agenda

HYDE ENGINEERING

1. Why install non-exporting storage?
2. What does it mean to be "non-exporting"?
3. How do you ensure sites are non-exporting?
4. What are potential safety concerns interconnecting non-exporting storage? How do they compare to other equipment on the distribution system?
5. What challenges exist with storage implementation?
6. Existing rules for interconnecting non-exporting resources
7. Q&A
8. Appendix - Simplified Single Line Diagram

Arizona ACC Interconnection Workshop - 4/13/16
Why non-exporting storage?

HYDE ENGINEERING

Non-exporting storage offers three primary system benefits:

1. Retail bill management (demand charge reduction, TOU charge reduction)
2. Advanced DR-like response if/when utilities can provide a direct signal to reduce load during system peak
3. Backup (and, with solar, perpetual island) capabilities during power outages

Arizona ACC Interconnection Workshop - 4/13/16
What does "non-export" mean?

HYDE ENGINEERING

A "non-export" system is defined as:

1. A system that does not generate power past the point of common coupling between the utility and host customer
2. A system where all generation is absorbed by the local customer load, particularly in response to a retail tariff or DR-like signal

Energy efficiency, regenerative elevators, and solar (or other DG systems) with reverse power flow relays can also be considered "non-export"

Arizona ACC Interconnection Workshop - 4/13/16
How is "non-export" ensured?

HYDE ENGINEERING

Ensuring that a system does not export power across the point of common coupling can be ensured in a few ways:

1. Requiring the system to be no greater than a certain percentage of the host customer's peak or average load (this percentage may be different for radial vs. networked distro systems)
2. Commissioning of an intelligent site controller and control scheme that responds to the utility's price or DR signals
3. It's the law! Customer contracts with the utility through Generating Facility Interconnection Agreement (GFIA) which outlines the rules for operating a non-export system

Arizona ACC Interconnection Workshop - 4/13/16
What are the safety concerns with non-export?

HYDE ENGINEERING

Non-export systems can cause several potential safety and distribution equipment issues:

1. Accidental export could energize distribution equipment during power outage. Satisfied by UL1741/IEEE1547. Only UL-listed (field inspections acceptable) equipment allowed
2. On distribution circuits with high solar penetration, accidental export could exacerbate voltage issues. Satisfied with intelligent control and minimum load requirements
3. Import (i.e., charging) during local peak could overload transformers or other distribution equipment. Satisfied by checking service ratings before installation (same as any other load) per NEC, also with intelligent control

Arizona ACC Interconnection Workshop - 4/13/16
What are some challenges with implementation?

HYDE ENGINEERING

In our experience non-export faces many implementation challenges that can increase costs and upset customers:

1. Jurisdictional permitting - new technology faces greater scrutiny due lack of standards and code; also permitting fees can vary from hundreds to tens of thousands
2. When adding storage to facilities that already have NEM generation, does the non-export or NEM system or both have to be metered?
3. Unclear disconnect type, location, and utility access requirements can cause project delays and cost overruns
4. Secondary networks are more susceptible to accidental export scenarios, but protection schemes can be overly expensive

Arizona ACC Interconnection Workshop - 4/13/16
Resources for non-export interconnection

HYDE ENGINEERING

- California Rule 21 - fast turnaround for non-export resources, most states appear to be adopting this rule
- UL 1741/IEEE 1547 - safety/technical standard for utility-interactive inverters
- UL 1973 - safety standard for stationary batteries
- UL 9540 - developing standard for energy storage systems (combined inverter and battery)

Thank You and Q&A

HYDE ENGINEERING

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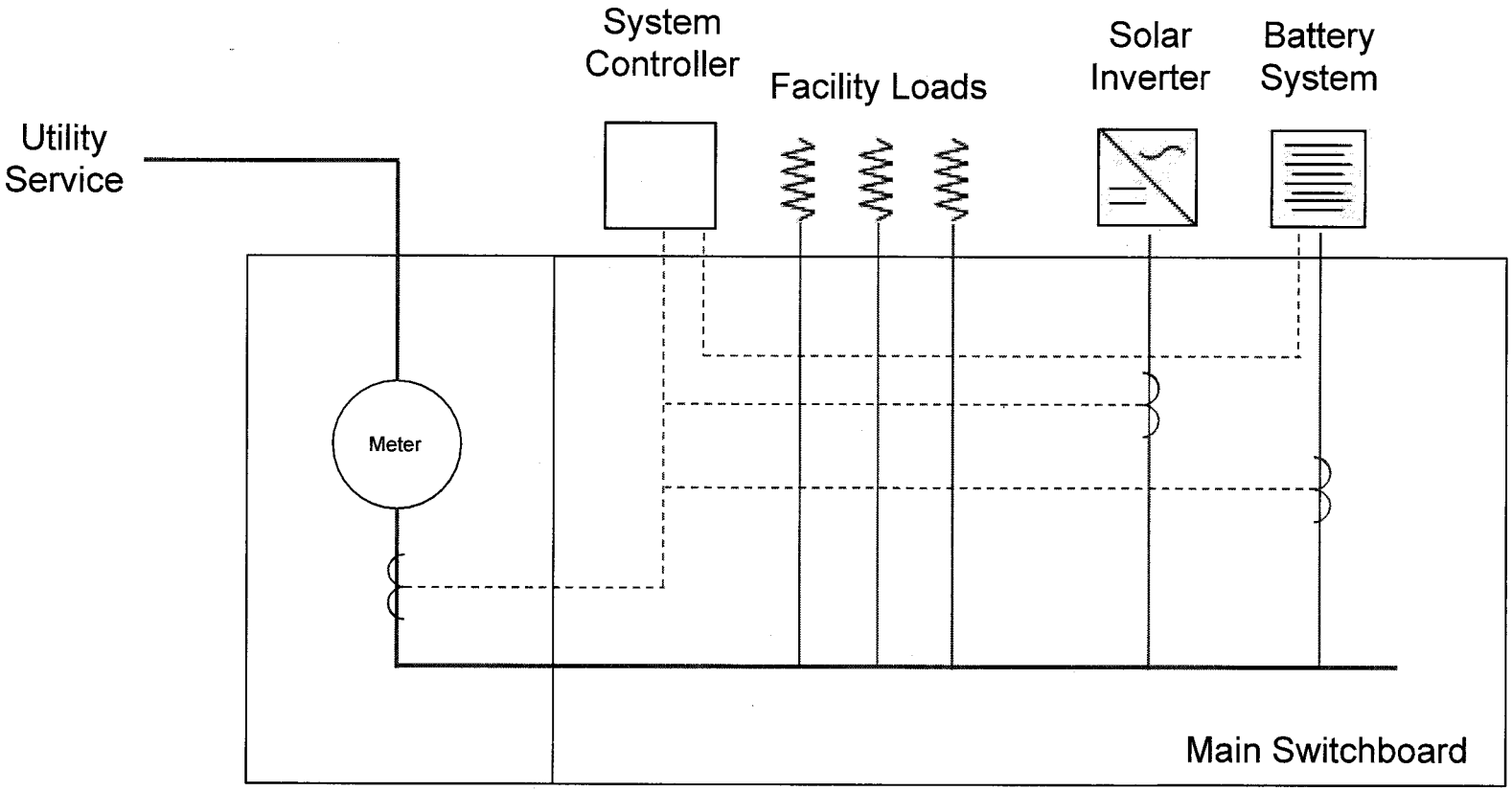
Appendix
Simplified Single Line Diagram

HYDE ENGINEERING



WESTERN RESOURCE ADVOCATES

PROTECTING THE WEST'S LAND, AIR, AND WATER

Arizona Interconnection Workshop

Ken Wilson

April 13, 2016

Context

- Arizona needs approved interconnection rules and standards
- Staff's draft proposed rules are a good starting point
- FERC has proposed guidelines
- WRA is proposing edits to Staff's draft proposed rules based on
  1. FERC final Rules
  2. IREC model rules
  3. NREL recommendations

WRA filed Comments and edits to Staff's draft proposed rules in July 2015. My comments today are based on that filing.

WRA would like to thank the Interstate Renewable Energy Council (IREC) for assistance in developing our positions

Screening Requirements – Level 1

WESTERN RESOURCE ADVOCATES

Level 1 – Super Fast Track

Proposal: Raise the 10 kW limit to 25 kW

- Limited to inverters that meet UL 1741
- Systems required to pass Screens (E) and (F)
- Also required to meet Screens (A) through (D) and (J)
- Screen (A) sets a limit on peak generation on the feeder (more on this later)
- Screen (B) sets a limit on Fault Current at any point on the Distribution System
- Screen (C) addresses short circuit interrupting capability
- Screen (D) sets interconnection type
- Screen (G) addresses a 10 MW limit in areas with transient stability limitations

Screening Requirements – Level 2 Fast Track

The 2 MW limit is too high in some cases and too low in others. The FERC recommendation is the following:

Fast Track Eligibility for Inverter-Based Systems		
Line Voltage	Fast Track Eligibility Regardless of Location	Fast Track Eligibility on a Mainline[1] and ≤ 2.5 Electrical Circuit Miles from Substation[2]
< 5 kV	≤ 500 kW	≤ 500 kW
≥ 5 kV and < 15 kV	≤ 2 MW	≤ 3 MW
≥ 15 kV and < 30 kV	≤ 3 MW	≤ 4 MW
≥ 30 kV and ≤ 69 kV	≤ 4 MW	≤ 5 MW

Screen A – Feeder Loading Criteria

FERC recommends maintaining the 15% of peak load criterion for aggregated generation on a feeder, which is included in the proposed rule.

FERC has added a Supplemental Review process when feeders are at or near the 15% threshold. Many states have found that forcing small systems to go through lengthy study processes cause large backlogs that are burdensome to all parties.

WRA has added language for a Supplemental Review process to our suggested revisions to staff's suggested rules.

WRA suggests deleting the final sentence from the Screen A criteria as the concern is better addressed with the Supplemental Review

Screen E – Capacity limitation on Small Systems

WESTERN RESOURCE ADVOCATES

WRA recommends changing the 10 kW limit for small systems to 25 kW

NREL recommends a 25 kW limit

IREC recommends a 25 kW limit and many states have adopted this limit.

FERC recommendations include a 20 kW limit, but the issue was not addressed in the proceeding.

The 25 kW limit could probably be raised – but discussion would be needed with the utilities.

Screen I – Generation Facility capacity

Screen I states that a generation facility cannot exceed the capacity of the customer's existing electric service.

WRA recommends adding the following language:

> "... unless there is a simultaneous request for an upgrade to the Customer's electrical service commensurate with the capacity of the Generating Facility or if the Generating Facility is configured to never inject power onto the feeder that exceeds the capacity of the electrical service."

This additional language still prevents the injection of more net power onto the Distribution Grid than the customer's service capacity.

Supplemental Review

FERC recognized the need for a supplemental review process when an application fails the Super Fast Track and Fast Track approvals due to high penetrations of DG.

Situations can occur when DG penetration is such that new systems fail the 15% criteria, but the feeder can easily host additional DG.

Small system applications are then unnecessarily put into the lengthy study process, creating backlogs.

Arizona should incorporate the FERC SGIP language for Supplemental Review. This language has been included in WRA's markup rules.

External Disconnect Switches

External Disconnect Switches are not necessary for inverter-based systems smaller than 25 kW.

This type of switch is redundant for certified inverter-based equipment

There is little record of these switched actually being used

NREL and IREC do not believe that external Disconnect Switches are necessary on small systems with certified inverters.

WRA has added language in the Disconnect Switch definition to implement this change.

Required use of Advanced (Smart) Inverters

WESTERN RESOURCE ADVOCATES

Smart Inverters have features that are beneficial to the Distribution Grid

- Ride Through capability
- Voltage and frequency support
- Improved VAR support
- Remote shut down of the DG system when necessary for grid protection

Arizona should require smart inverters on all systems over 10 kW after some date certain.

Arizona should initiate a separate proceeding at an appropriate time in the future to investigate control functions and communications standards for smart inverters.

Pre-application Reporting and Mapping

Many states and utilities have found it advantageous to provide information to prospective solar customers and providers on grid conditions that could limit the hosting ability of feeders

This could be done with reports or maps or both

The ACC should require utilities to provide reports and/or maps that give interested parties enough information to determine where limitations are occurring or will occur in the near future.

Updating Certification Requirements and Standards

Rules and standards will need to be updated and revised from time to time

Many states convene technical working groups to cover emerging issues

- Problems with existing rules
- Problems with the interconnection process
- Changes to national standards (IEEE, FERC, etc.)
- Need to more extensive rules for control of smart inverters
- Etc.

Energy Storage Issues and Considerations

WESTERN RESOURCE ADVOCATES

Behind the meter battery storage associated with DG is immanent.

Arizona needs to have rules in place that provide surety for both the utilities and customers who want to install battery storage.

WRA believes that behind the meter battery storage should be treated in the same way that DG is treated with respect to basic interconnection.

Smart inverters should be required on all installations.

Communication standards should be quickly addressed so utilities can communicate with behind the meter battery storage systems.

It may be most efficient for utilities to have the ability to control charge and discharge of battery storage systems.

Microgrids

WESTERN RESOURCE ADVOCATES

Interconnection of customer owned microgrids that have the ability to fully "island" will need to be addressed by utilities in the future.

Except in limited "campus" type situations, true microgrids are beyond the scope of the currently proposed interconnection rules.

Large customers, such as universities and military bases, can negotiate microgrid interconnection directly with utilities.

More general interconnection of microgrids will be informed by rules that are developed for the interconnection of smart inverters on DG systems and smart inverters that control DG/Battery Storage systems.

Technical Issues Related to Safety

The safety standards that are required for new DG and DG/Battery Storage systems, whether UL listing or IEEE standards, along with the proposed interconnection rules that we are addressing in this proceeding, should provide adequate safety standards for interconnection.

If additional safety issues arise, they should be addressed in a speedy manner.